STUDY OF OCEAN BOTTOM INTERACTIONS WITH ACOUSTIC WAVES BY A NEW ELASTIC WAVE PROPAGATION ALGORITHM AND AN ENERGY FLOW ANALYSIS TECHNIQUE

Ru-Shan Wu
Institute of Tectonics, University of California
Santa Cruz, CA 95064
phone: (408)459-5135 fax: (408)459-2127
email: wrs@earthsci.ucsc.edu
Xiao-Bi Xie
Institute of Tectonics, University of California
Santa Cruz, CA 95064
phone: (408)459-5094 fax: (408)459-2127
email: xie@earthsci.ucsc.edu
Award number: N00014-95-1-0093

Propagation (theory, modeling and computation)

LONG-TERM GOALS

Develop a new method and the code to simulate 3D acoustic/elastic wave propagation and interaction with the ocean water and ocean bottom environment. The method will be applied to numerical simulations to study the wave/sea-bottom interaction, energy partitioning, scattering mechanism and other problems that are crucial for many ocean bottom-surveying techniques. Our understanding on shallow water acoustic wave propagation and its interaction with sediments can be improved.

SCIENTIFIC OBJECTIVES

Improve and develop the ECS (Elastic Complex-Screen), a new one-way elastic wave propagation method, and apply it to the ocean bottom environment to study the elasto-acoustic wave propagation in complex laterally heterogeneous media, including rough surface and random volume heterogeneity.

APPROACH

The basic approach is connecting the acoustic phase screen algorithm and elastic complex screen algorithm with a boundary condition, which may permit certain types of roughness. With this method, the acoustic signal can propagate all the way through seawater and solid bottom. Reflections from both water and sub-bottom structures can also be calculated and propagated upward to the surface. A free surface condition can be added at either the source side or receiver side.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **30 SEP 1997**	2. REPORT TYPE	3. DATES COVERED **00-00-1997 to 00-00-1997**
4. TITLE AND SUBTITLE **Study of Ocean Bottom Interactions with Acoustic Waves by a New Elastic wave Propagation Algorithm and an Energy Flow Analysis Technique**		5a. CONTRACT NUMBER
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **University of California, Santa Cruz,Institute of Tectonics,Santa Cruz,CA,95064**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a REPORT **unclassified**	b ABSTRACT **unclassified**	c THIS PAGE **unclassified**	**Same as Report (SAR)**	**3**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

WORK COMPLETED

In the year of 1997, we further tested the elastic one-way code for 3D heterogeneous model. The results have been compared with 3D finite-difference results generated on a parallel computer. Based on the plane wave decomposition, we also developed a free surface and source condition for elastic one-way wave equation method. We finished the code. The boundary condition has been connected to the existed one-way elastic code. Numerical examples have been tested and checked.

RESULTS

Unlike the full wave method, the one-way method is usually derived for a source free situation. With our boundary condition and source term combined, the elastic complex screen one-return algorithm can handle forward propagation and primary reflection, as well as buried source and free surface related wave phenomena.

IMPACT/APPLICATION

The phase screen method and elastic complex screen method are highly efficient methods for calculating wave propagation and reflection in sea water and sea bottom environments. The newly developed boundary condition and source term can be applied at either the source side or the receiver side. With this boundary condition, many of the free surface effects, e.g., reflected P and S-waves, secondary surface waves, etc., can be generated. Since this method is based on the plane wave decomposition, it is especially useful for one-way methods based on the wavenumber domain Fourier transforms.

TRANSITIONS

None

RELATED PROJECTS

The ONR supported project is part of researches conducted under a general title of Modeling and Imaging Project (MIP) at University of California, Santa Cruz. The MIP is co-sponsored by AFOSR, DOE, DOD, ONR, GRI, NSF and some industrial companies. The MIP is aiming at developing new theories, methods and algorithms for modeling and imaging in 3D complex environments. This project emphasizes on the fast one-way propagation methods, and also searches for the application of newly developed technologies, such as the wavelet transform, in the wave propagation theory.

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